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Pupillary dilatation has recently been reported as a physiological measure of degree of attention paid to environmental stimuli (Hess and Polt, 1960, 1964). Hess and Polt's research has operationally defined one variable and has provided data that allows researchers to speculate about several others. This variable is interest-disinterest. The purpose of the present investigation was to examine the relationship between sociometric choice patterns and pupillary behavior. Some 18 sixth-grade subjects (Ss) completed a sociometric questionnaire in which they indicated three friendship and three nonfriendship choices. Black and white photographs of each S were made and served as the experimental stimuli. The stimuli were arranged and shown to each S according to their responses to the sociometric questionnaire. No significant differences in pupillary dilatation patterns were found among Ss when viewing stimuli depicting friendship choices as opposed to nonfriendship choices. Pupillary dilatation to pictures of friends was, on the average, not significantly different from dilatation patterns to pictures of nonfriends. Results were discussed in terms of (1) theoretical issues relevant to sociometric choice patterns, and (2) the interpretation of pupillary response patterns and their relationship to inquiry in the social sciences. (Author)

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SOCIOMETRIC CHOICE: A STUDY IN PUPILLARY RESPONSE

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School of Education
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SOCIOMETRIC CHOICE: A STUDY IN PUPILLARY RESPONSE[1] [2]

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[1] A paper presented at the American Educational Research Association Meeting, Chicago, Illinois, February 8, 1968.

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Abstract

Pupillary dilatation has recently been reported as a physiological measure of degree of attention paid to environmental stimuli (Hess & Polt, 1960, 1964). Hess and Polt's research has operationally defined one variable and has provided data that allows researchers to speculate about several others. This variable is interest-disinterest. The purpose of the present investigation was to examine the relationship between sociometric choice patterns and pupillary behavior. Eighteen sixth grade Ss completed a sociometric questionnaire in which they indicated three friendship and three nonfriendship choices. Black and white photographs of each S were made and served as the experimental stimuli. The stimuli were arranged and shown to each S according to their responses to the sociometric questionnaire. No significant differences in pupillary dilatation patterns were found among Ss when viewing stimuli depicting friendship choice as opposed to nonfriendship choices. Pupillary dilatation to pictures of friends was, on the average, not significantly different from dilatation patterns to pictures of nonfriends. Results were discussed in terms of a) theoretical issues relevant to sociometric choice patterns and b) the interpretation of pupillary response patterns and their relationship to inquiry in the social sciences.

Sociometric Choice: A Study in Pupillary Response

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Factors classically described as involved in the regulation of pupillary behavior include: accommodation, the light reflex and autonomic nervous activity (Loewenfeld, 1958). In a synthesis of the literature on mechanisms which regulate pupil size, Lowenstein and Loewenfeld (1962) concluded that during various cognitive and emotional states, regulatory mechanisms involving cortico-thalmo-hypothalamic systems also participate in the regulation of pupil size. Pupil diameter has recently been reported as a physiological measure of degree of attention paid to environmental stimuli (Hess, 1965; Hess & Polt, 1960, 1964, 1966; Hess, Seltzer & Shlien, 1965). This line of research has operationally defined one variable and has provided data that allows researchers to speculate about several others. This variable is interest-disinterest.

Hess & Polt (1960) have postulated that the pupil dilates in response to positive affects or "interests" and constricts with negative affects or "interests". Other investigators have subsequently confirmed the dilation response to positive stimuli, but have been unable to observe a constriction response to negative stimuli (Woodmansee, 1967; Pavio & Simpson, 1966: Peavler & McLaughlin, 1967). Numerous other studies have shown that increase in pupil diameter is significantly related to attending to sensory stimuli (Hakerem & Sutton, 1966), autonomic fatigue in functional psychosis (Rubin, 1960), and the amount of mental effort involved in storing information for report (Kahneman & Beatty, 1966).

In summary, affective stimuli (such as attitudinal stimuli) and cognitive stimuli (such as memory for digits) have both produced dilatation of the pupil. But pupillary behavior has also been postulated to be a bi-polar indicator of degree of attention; dilatation indicates positive "interest" or affects and constriction indicates negative "interests" or affects. While the findings in the above brief review are the result of initial inquiries, they are somewhat unrelated and unsystematized, so that it is not difficult to account for the diversity of hypotheses advanced to explain the physiological and psychological linkage between pupillary response and human behavior.

The present study was designed to determine the nature and degree of pupil changes in response to positive and negative visual stimuli and to attempt to relate pupillary behavior to previously indicated indices of sociometric choice. Sociometric choices were employed as the independent variables to differentiate those Ss who respond primarily with "pleasurable interest" from those Ss who respond primarily with "negative disinterest" Head and shoulder pictures of "smiling" and "neutral" faces of sociometric choices were used to elicit greater emotional involvement in the task.

In regard to the sociometric variables chosen, it was expected that the viewing of reciprocated and unreciprocated sociometric choices would produce significantly larger pupillary dilatation than the viewing of negative sociometric choices and that there would be significantly larger pupillary dilatation to pictures of smiling faces than to neutral faces. Also, since teachers have long been considered a dynamic force in the classroom, it was decided to include a smiling and a neutral picture of the classroom teacher. Because of the dynamic role the teacher plays in the classroom, it was

expected that there would be significantly more pupillary dilatation to pictures of the teacher than to either unreciprocated or negative sociometric choices.

Method

Subjects

The sample consisted of 13 male and 5 female students selected from a self-contained 6th grade classroom.

Each S completed a sociometric questionnaire. The questionnaire consisted of two questions: 1) "Who are your three best friends?" and 2) "Who are three people you do not get along with?" From these questions reciprocated friendship, unreciprocated friendship and dislike choices were tabulated for each S. Black and white head and shoulder photographs were taken of each S and of the teacher; Kodak direct positive panchromatic reversal transparency film (DP402) was used. For the smiling condition Ss were simply instructed to smile; for the neutral condition, Ss were instructed to relax and were directed to look at the camera. The order of test stimulus presentation was: self, reciprocated friendship choice, dislike choice, unreciprocated friendship choice and the teacher. In each of the above conditions, the neutral test stimulus was presented prior to the smiling test stimulus. Each test stimulus was preceded by a control stimulus equated for luminence.

The apparatus employed for recording pupil size and stimulus presentation was that designed and employed by Hess (1965). Both test and control stimuli were viewed for 10 sec. each. With camera speed regulated at a constant rate of two frames per sec., 20 infrared photographs were obtained for each test and control stimulus. Projection of the processed film onto a trans-

lucent screen, which magnified the image by a factor of 20, permitted pupil diameter to be measured by hand with a millimeter ruler. By comparing the mean diameter of 20 frames associated with its control stimulus, it was possible to determine the percent of dilatation or constriction occuring in response to each test stimulus.

Results

Table 1 shows the average pupil size and percent change of dilatation or constriction occuring for each of the test stimuli. It is clear from the

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insert Table 1 about here

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data presented in Table 1 that there are no significant differences between any of the means for the test stimuli and that there are no significant differences between any of the means for the percent change scores. The t-statistic between all pairs of test stimuli averaged over all Ss never exceeds .156 with 32 degrees of freedom. A t-value of 2.037 is necessary to obtain a 5 percent level of significance with 32 degrees of freedom.

The percent change of dilatation or constriction occurring for each of the test stimuli, averaged over all Ss, is shown in the form of a histogram in Figure 1. There are no statistically significant differences among these percent change scores.

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insert Figure 1 about here

TABLE 1

Average Pupil Size and Percent Change Index for all Subjects with more than Half the Data Present for Control and Experimental Stimuli

	Stimuli	Mean	SD	N	Percent Change
1.	Control	71.0	6.96	17	0.0
2.	Self: Face Neutral	70.8[1]	4.93	18	-0.29
3.	Control	72.0	5.88	18	1.78
4.	Self: Face Smile	72.8	4.93	16	1.01
5.	Control	72.7	4.72	17	-0.08
6.	Reciprocated Friend-Neutral	72.8	5.64	17	0.18
7.	Control	71.8	5.62	18	-1.41
8.	Reciprocated Friend-Smile	72.1	5.25	17	0.34
9.	Control	72.3	6.22	18	0.33
10.	Dislike-Neutral	72.4	6.51	17	0.19
11.	Control	70.4	6.65	18	-2.74
12.	Dislike-Smile	72.1	6.32	17	2.34
13.	Control	70.4	7.17	18	-2.29
14.	Unreciprocated Chosen-Neutral	70.4	8.48	17	-0.06
15.	Control	68.4	10.09	17	-2.89
16.	Unreciprocated Chosen-Smile	69.4	9.47	16	1.52
17.	Control	69.9	10.48	17	0.76
18.	Teacher-Neutral	68.9	11.12	16	-1.56
19.	Control	68.1	10.64	17	-1.07
20.	Teacher-Smile	70.7	12.26	17	3.77

[1] t-statistic between all pairs of test stimuli averaged over all subjects never exceeded .156 with 32 degrees of freedom. (A t-value of 2.037 is necessary to obtain a 5% level of significance with 32 degrees of freedom.)

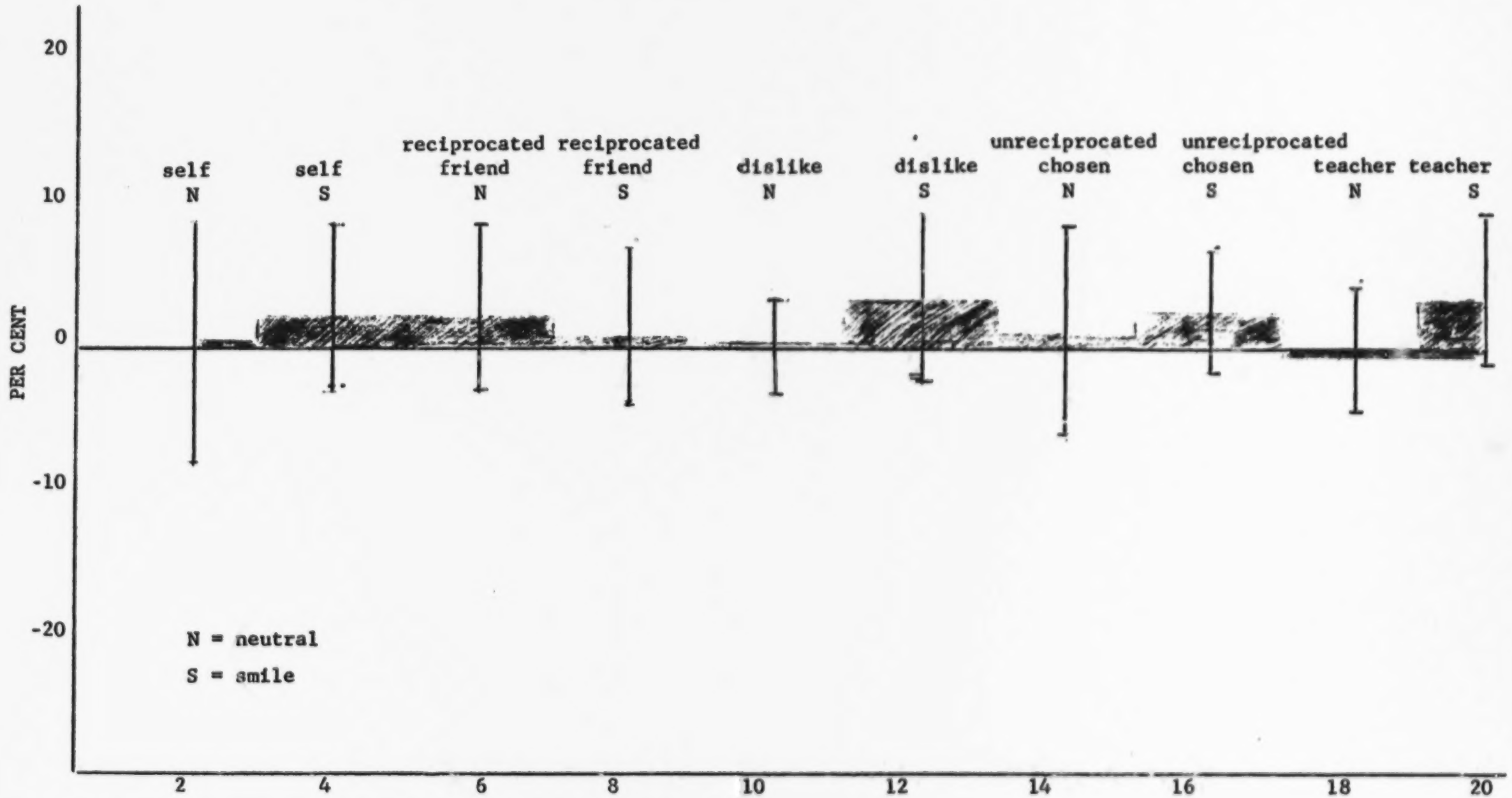

FIGURE 1
PER CENT ENANGE, AVERAGED OVER ALL STUDENTS (N=18)

Figure 2 shows pupil size, in millimeters, averaged over all eighteen Ss. It is clear from this graph that both the control and the test stimuli and all of the test stimuli did not differ significantly from one another. What is of interest, however, is the significant amount of pupillary variability with respect to each of the control and test stimuli and the increase in variability over time--that is, from stimulus 1 - 20.

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insert Figure 2 about here

It is clear from these data that the viewing of reciprocated and unreciprocated sociometric choices does not produce significantly larger pupil diameters than the viewing of a negative sociometric choice. It is also clear that there are no significant differences in pupil diameter for viewing neutral or smiling faces. Although the data is not significant, it is of interest to note that there is more pupillary dilatation to the test stimulus of the teacher, on the average, than there was to any other test stimulus.

Discussion

Since a positive percent change score indicates a larger pupil size when S views a test stimulus than a preceding control, it is clear that increased pupil diameter was found for all of the test stimuli even though the increases are not significant. Thus, the results from this study clearly show that increases in pupil diameter occur to a test stimulus, but that neither dilatation nor constriction may be taken as an indicator of interest-disinterest. In short, pupillary response patterns were not able to discriminate between reciprocated, unreciprocated and dislike sociometric choices. The average pupil diameter and percent change scores to the stimulus of the

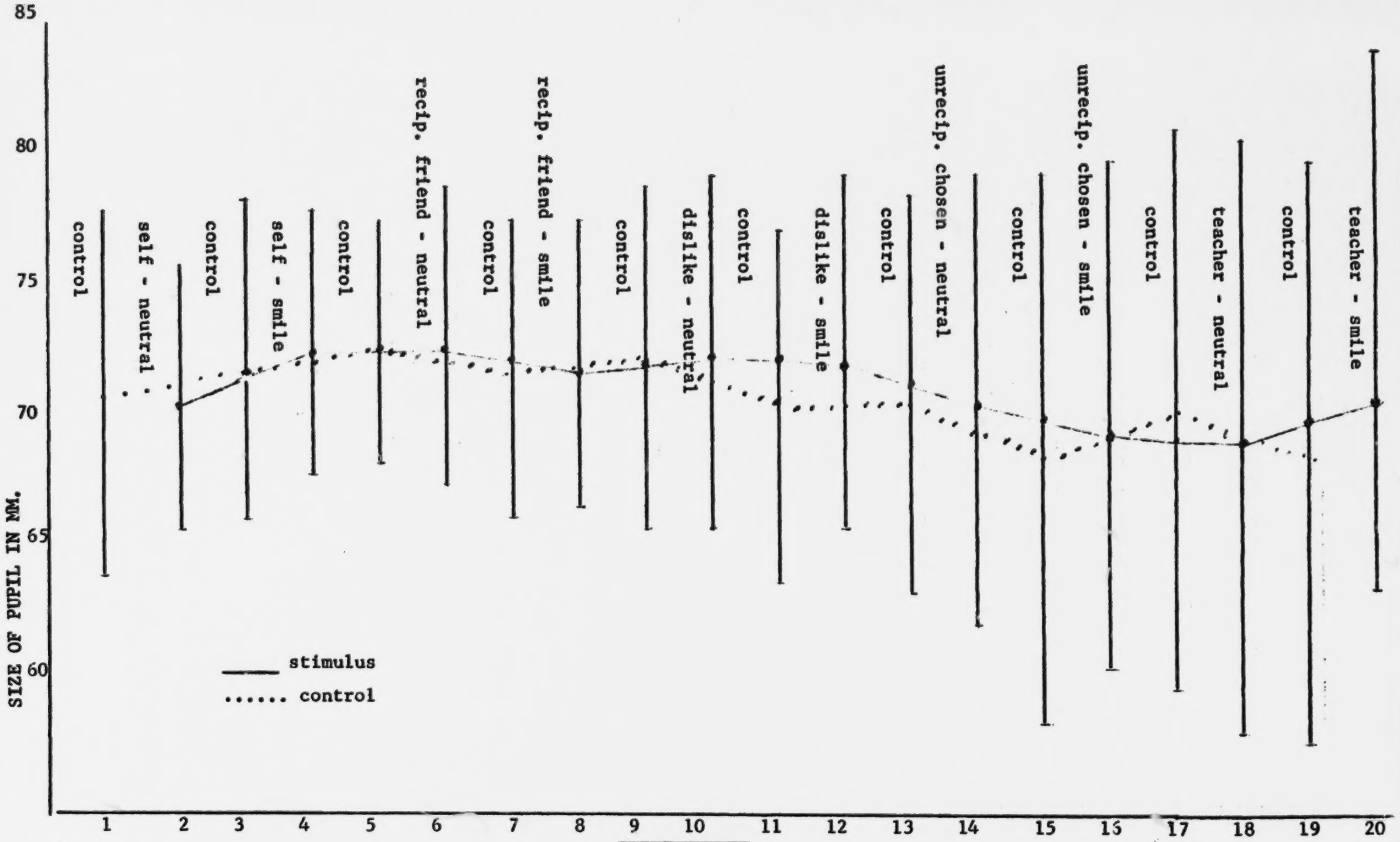

FIGURE 2

PUPIL SIZE, IN MM., AVERAGED OVER ALL STUDENTS (N=18)

teacher (neutral and smiling) were not significantly different from the average pupil diameter and percent change scores to the other test stimuli.

The lack of relationship between pupil diameter and theoretically rated pleasantness of viewing a picture of a friend vs. a picture of a nonfriend is in agreement with results reported by Paivio & Simpson (1966) and Peavler & McLaughlin (1967). It is possible that the test stimuli were not provocative enough to produce dilatation responses since there is a considerable amount of recent evidence that dilatation is closely associated with stimuli or tasks which produce or require attention (Beatty & Kahneman, 1966; Kahneman & Beatty, 1966, 1967). Significant increase in pupil variability does not, however, explain the lack of evidence for a constriction response to negative stimuli as postulated by Hess (1965).

In one significant respect this study has yielded relatively little by way of an answer to the question of whether pupil size is related to interest-disinterest. This is primarily because the intra-subject pupil response was not reliable. A careful examination of the raw data shows that the pupil is extremely active at all times. Changes in pupil diameter during a given stimulus were as extensive as 15% to 25% in a half-second period. As can be seen from Figure 2, variability increases substantially with viewing time. However, low reliability is only one of the many problems to be overcome in this type of research. Discussion of methodological issues and suggestions for workable solutions are reflected in the excellent studies of Hakerem (1962), Woodmansee (1965) and Loewenfeld (1962). Some of these issues are reflected in problems of controlling for changes in pupil response as a function of accommodation, fatigue, dark adaptation, pupillary variability, the near vision reflex, instrumentation, etc.

Speculations as to the meaning of pupil dilatation may be reflected in what Freud termed the "stimulus barrier" (Rappaport, 1959). Freud conceived of the perceptive apparatus as a series of layers. The outermost layer's function is to diminish the strength of excitations of stimuli coming into the organism. Such an interpretation suggests that pupillary dilation may be an index, under certain conditions, of the organism's ability to decrease or increase the strength of internal or external excitations. Thus, for example, it may take as much "energy" to "concentrate" one's attention on a friend as on someone that is disliked, or on a powerful authority figure.

Theoretical issues relating to pupillary constriction in a visual stimulus, provided light controls are employed, have been raised by Loewenfeld (1966). She argues that optically a picture is a combination of bright and dark areas which reflect light energy to the retina. Thus, theoretically, no matter how much the contrast in a given test stimulus is reduced, the pupil will respond to differences in light flux. In addition, there may also be considerable individual differences in sensitivity to the light flux properties of the stimulus. Pictures in color complicate this problem further, since neuro-color receptors of the eye are not disbursed evenly over the whole retinal area where the stimulus is projected. Shifting from one stimulus to another or from one image to another within a given stimulus necessarily results in retinal stimulation and hence pupillary response. In short, Loewenfeld claims that the interaction of these uncontrolled variables in the use of visual stimuli may well account for the constriction responses of some subjects.

Although Loewenfeld's criticisms of the use of visual stimuli are significant, it should be pointed out that studies by Kahneman & Beatty, (1966,

1967), Hess & Polt (1966) and others have shown that, among others, auditory and olfactory stimuli serve as viable alternatives to using visual stimuli in pupillographic research. Certainly, additional clues to the complexities involved in understanding the meaning of pupillary behavior are afforded in repeated failures to condition constriction through the use of classical conditioning techniques (Hilgard, 1941, 1949; Young, 1958), and that the effects of suggestions of alertness in hypnosis significantly increase pupil diameter (Bartlett et al, 1967). In conclusion, a great deal of basic research is necessary before a generalization can be reached that pupil diameter is an indicator of interest-disinterest, functional psychoses, attention or cognitive complexity.

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ABSTRACT

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